5.2 Hazard Quotients

The HQ for the inhalation pathway can be calculated with the following general equation:

HQ = EC/(Toxicity Value[1] x 1000 μg/mg)	**(Equation 12)**
Where:	HQ (unitless) = Hazard Quotient; EC ($\mu g/m^3$) = exposure concentration (See Equations 7 or 8); Toxicity Value (mg/m^3) = Inhalation toxicity value (e.g., RfC) that is appropriate for the exposure scenario (acute, subchronic, or chronic).

[1] Risk assessors should refer to the flowchart (Figure 2) to select an appropriate inhalation toxicity value for the exposure scenario at a site in order to calculate the HQ.

6. EXAMPLE EXPOSURE SCENARIOS

This section of the guidance includes examples of the types of exposure scenarios risk assessors may encounter when evaluating inhalation exposures at waste sites. Each scenario includes sample values for exposure parameters and reviews the process of estimating the EC and risks for cancer and other health effects. These examples are provided for illustrative purposes only and are not representative of every exposure scenario that could be encountered at a site. Furthermore, risk assessors should use site-specific values for exposure parameters if practicable when estimating ECs and risk levels or HQs. This would typically require some information on activity patterns for the specific site or the use of professional judgment. If default values are to be used for certain exposure parameters, please consult the Superfund website for up-to-date information on Superfund-recommended default exposure parameters.[34]

6.1 Residential Receptor

An example of a residential scenario could consist of inhalation exposure for up to 24 hours per day, up to 350 days per year for 6 to 30 years. When estimating cancer risk for this type of scenario, Equation 6 is recommended to calculate an EC and Equation 11 is recommended to estimate risk. For estimating hazard quotients for cancer or non-cancer effects, this scenario can be evaluated using the steps outlined in Figure 2. The duration of this scenario ranges from 6 to 30 years, which can be considered chronic (because it consists of repeated exposures for approximately 10 percent of a receptor's lifespan). The frequency of this scenario is generally as frequent as a chronic toxicity test and therefore Equation 8 is recommended to derive a chronic EC and Equation 12 with a chronic toxicity value is recommended to calculate an HQ. If information about multiple MEs is available, risk assessors should proceed according to Section 3.4 to estimate ECs to use in estimating cancer risks or HQs.

When assessing the risk under the residential scenario for children, the risk assessor should keep in mind that exposure parameters, specifically those related to activity patterns (e.g., exposure time, frequency, and duration) may be different for children and adults at the same site. For example, due

[34] http://www.epa.gov/oswer/riskassessment/superfund_hh_exposure.htm.

to outdoor play patterns, children may spend more time near the source of contamination than adults, and thus would have higher exposure time and/or exposure frequency values than adults living in the same location.[35] For indoor vapor intrusion from the subsurface, very young children might be more highly exposed due to substantial time spent indoors.

Beyond the consideration of activity patterns, MEs, and chemicals with a mutagenic MOA for carcinogenicity (as described in Section 5.1), no additional adjustments to account for specific child receptors should be made to the default values. Appendix A of this document is intended to illustrate that the use of default values sufficiently covers age-related variation in DAF or HEC values derived using the EPA *Inhalation Dosimetry Methodology's* default approach.

6.2 Commercial-Industrial/Occupational Receptor

An example of a commercial-industrial or occupational inhalation exposure scenario could be characterized by full-time workers (e.g., 8 hours per day, 5 days per week) in an indoor setting, such as an office building, exposed via vapor intrusion of subsurface contamination on a daily basis for 5 to 25 years. When estimating cancer risk for this type of scenario, Equation 6 is recommended to calculate an EC and Equation 11 is recommended to estimate risk. Following the flowchart in Figure 2, the duration and exposure pattern of this scenario would typically be considered chronic. Therefore, Equation 8 is recommended to derive a chronic EC and Equation 12 is recommended (with a chronic RfC) when calculating an HQ for cancer or non-cancer effects. If information about multiple MEs is available, risk assessors should proceed according to Section 3.4 when deriving ECs to use in estimating cancer risks or HQs. Exposure parameters should be adjusted to consider the exposure time, frequency and duration for this scenario, which may differ from a residential scenario. Risk assessors should also use appropriate exposure parameters for outdoor workers who, similar to children, may spend more time near a source of contamination than indoor workers.

6.3 Construction Worker

One example of a construction worker scenario could involve a long-term project (1-2 years) with workers exposed regularly to contaminant vapors and fugitive dust (8 hours per day, 5 days per week). When estimating cancer risk for this type of scenario, Equations 6 and 11 are recommended to calculate an EC and the risk estimate, respectively. Following the flowchart in Figure 2, the duration of this exposure scenario would typically be considered subchronic. In addition, this exposure is generally as frequent as a subchronic toxicity test. Therefore, Equation 8 is recommended to derive a subchronic EC, and Equation 12 is recommended for use with a subchronic toxicity value to calculate the HQ. If information about multiple MEs is available, risk assessors should proceed according to Section 3.4 when deriving ECs to use in estimating cancer risks or HQs.

6.4 Trespasser/Recreational Receptor

An example trespasser/recreational scenario could consist of an exposure of 1 to 2 hours per day, for 100 days per year or less. When estimating cancer risk for this type of scenario, Equations 6 and 11

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[35] For additional information about early-lifestage age groups to consider when assessing children's exposure to environmental contaminants, please consult EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (EPA, 2005d).

are recommended to calculate an EC and the risk estimate, respectively. Following the steps in Figure 2 for cancer or non-cancer effects characterized by an RfC, each exposure period should be assessed separately because this exposure lasts only one to two hours each day for an average of two days per week. Therefore, Equation 7 is recommended to derive acute ECs for each exposure period. In addition, Equation 12 is recommended for use with an acute toxicity value to calculate HQs for each exposure period.

7. TARGET CONCENTRATIONS FOR SCREENING ANALYSIS OF INHALATION PATHWAYS

For purposes of this guidance, risk-based screening levels are values that may be compared to the contaminant concentration in air to help risk assessors identify potential contaminants of concern. Screening levels can also be calculated for comparison with samples from source media at a site, such as soil. Screening levels are generally not appropriate for use as clean-up levels; they are intended to aid in initial evaluation of contaminants and exposure pathways of concern prior to proceeding with a baseline risk assessment.[36] If contaminant concentrations in air exceed the risk-based screening levels appropriate for the receptor population of interest, risk assessors should gather site-specific information to determine the need for any remedial action. The following sections outline a recommended approach for calculating screening levels in air as well as source media.

7.1 Target Contaminant Concentrations in Air

The equations recommended for estimating ECs and risk (Equations 6 through 12) can be used to calculate target contaminant concentrations in air by following the four steps outlined below in Table 4.[37]

If air samples from a site are found to be below the target concentration, the risk assessor can generally conclude that this pathway does not pose an unacceptable level of risk from the contaminant. If the concentrations are found to exceed the screening levels, the risk assessor should evaluate the inhalation pathway further by gathering additional site-specific data on contaminant levels, site conditions, and receptor characteristics.

7.2 Screening Levels for Other Media

Inhalation risk-based screening levels may also be calculated for media other than air, including soils, tap water, soil gas, and ground water. The soil gas and ground water values may be derived specifically to address concerns about vapor intrusion from subsurface contamination into indoor spaces.

[36] EPA regions, states, or other agencies may support unique screening levels for specific purposes that may differ from the method presented in this document. Generally, when using screening levels it is important that risk assessors understand the target risks, toxicity, and exposure assumptions as well as migration-attenuation assumptions on which they are based, and to apply them for their intended use.

[37] Target contaminant concentrations in air calculated according to the procedure outlined in this document are generally protective for direct inhalation exposures. This process should not be used to calculate concentrations in air to be protective of indirect exposures (e.g., ingestion of crops contaminated through air delivery or vapor phase transfer, ingestion of livestock or fish contaminated indirectly through air deposition or vapor phase transfer).